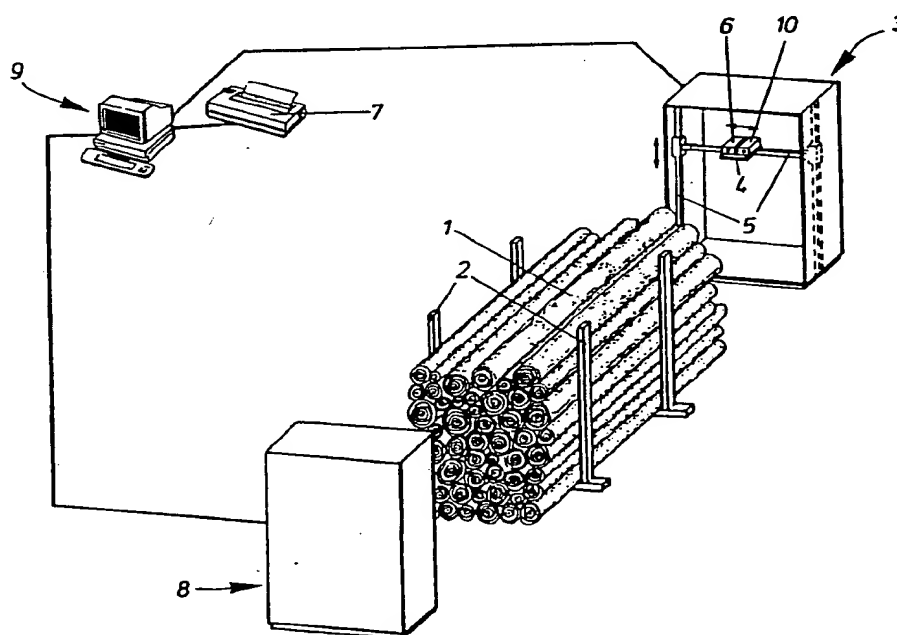




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(54) Title: A METHOD AND EQUIPMENT FOR MEASURING A PILE OF LOGS



(57) Abstract

The object of the invention is a method and equipment for measuring the magnitudes of a pile (1) of logs, particularly the volume of timber. It is the intention of the invention to create a new and simple method for measuring the magnitudes of a pile of logs. According to the invention, the outlines of the ends of the logs are recognized from both ends of the pile and the location of the recognized outlines is measured and, if necessary, the entire weight of the pile is measured, on the basis of which the desired magnitudes are calculated by means of a theoretical model.

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A Method and Equipment for measuring a Pile of Logs

The object of the invention is a method and equipment for measuring a pile of logs, in particular its volume.

5

Up until now immersion measurement, in which the amount of water displaced by the pile corresponds to its volume, has been used to measure the volume of a pile of logs. Often, however, data is required on the size distribution of the logs, both in
10 relation to diameter and length. In precise measurement according to the known technique, the entire pile needs to be taken to pieces and each log measured separately.

Finnish patent publications Nos. 51584 and 54971 show a method
15 of measuring the side density of a pile of wood. This takes place optically by measuring the ratio of dark and light areas at the end of the pile. In the method in accordance with publication No. 51534, the end of the pile is filmed with a TV camera, on the basis of the video signal of which the ratio
20 referred to is calculated. In addition to this, the length and width of the pile must be measured separately in order to be able to calculate an estimate of the solid cubic measure. The method does not provide an especially precise result, particularly as piles of wood are rarely the same length. The height
25 and length of the pile used in the calculations are average values, which must be estimated. A large possibility of error arises from this. Even the basic method, the measurement of the side density by means of the ratio referred to, has not been satisfactorily implemented in practice.

30

The intention of this invention is to create a new and simple method and equipment for the measurement of a pile of logs as automatically as possible. The principal characteristics of the method in accordance with the invention are presented in the
35 accompanying Patent Claim 1. The basis of the invention is the application of object recognition to recognize the ends of the logs of the pile, by means of which their location can be measured. The use of object recognition in this connection substantially improves the reliability of the measurement

compared with known methods. This is based especially on the registration of the form and location of the end of each individual log, on account of which the total magnitudes are not average magnitudes, but the total values of individual
5 recognized objects. Because the logs may cross over inside the pile, it is not necessarily possible to recognize both sides of the ends of the same log. Due to this, the calculation model in accordance with Patent Claim 2 is particularly advantageous. This provides the entire wood volume of the pile with a good
10 degree of accuracy. If both ends of the same log are recognized, its volume can be calculated, for example, as a truncated cone.

The characteristic features of the equipment in accordance with
15 the invention are presented in Patent Claim 4. The camera can be either a matrix camera or a normal analog video camera, the picture from which is digitalized separately. It is particularly advantageous to use a linear camera, because it can be installed in the same carrier as the distance measurement
20 device.

In what follows the invention is illustrated with the aid of the accompanying figures, which show by way of example a log pile measurement system equipped with two measurement units.
25 The log pile 1 is placed for measurement in fork 2, which then delimits the measurement area. The fork 2 is connected to an ordinary weighing device, by means of which the weight of the whole pile 1 is obtained. The basic components of the system are the measuring units 3 and 8 on either side of the pile
30 carried by the fork 2, and the calculating equipment 9. It consists of an AT-type microcomputer and the data on each pile comes from the printer 7 connected to it.

The measuring units 3 and 8 consist of a carrier 4 and its
35 transfer device 5 as well as the IR laser-pulse distance measurement device 10 and CCD linear video camera 6, which are installed on the carrier.

The measuring units 3 and 8 are located in relation to the pile fork 2 in such a way that they lie in the same line as the direction of the ends of the pile of logs. Fork 2 delimits the measurement area to about 2.8 m x 2.8 m. The transfer device 5 of the carrier 4 is dimensioned to cover the whole of this area in such a way that both filming and distance measurement take place perpendicularly to the ends of the pile.

The measurement is carried out as follows. The pile 1 of logs 10 to be measured is placed in fork 2. By means of the transfer device 5 the carrier 4 is moved in steps over the measuring area. After every horizontal pass the horizontal guide rail is lowered by a suitable step. The distance measurements are registered in the calculation equipment 9 as a matrix. The 15 linear camera 6 does not necessarily need to be moved over such a dense field. If the line sensor of camera 6 is vertical, a few passes are sufficient. In practice it is simpler to carry out the filming separately. The filming creates another matrix, in which one nucleus contains the picture nucleus in question 20 as a numerical value of the strength of light from 0...255.

The treatment of the picture begins by searching the picture matrix for limit-value points, in which the brightness of the picture changes sharply. After this, an attempt is made to fit 25 curves of various sizes to the limit-value points. Various kinds of criteria can be used to approve the outline of the end of a log. If, for example, the space between two curves that are near to one another strike more limit-value points than are the limit of acceptance, it can be assumed that these points 30 depict the end of a log. The remainder of the limit-value points that form part of the object can be easily found and the missing sections of the curve can be estimated. Data on the outlines of the ends of the logs and their location in an XY direction are obtain as the final result of the treatment of 35 the picture. The distance measurement data obtained from the places of the objects are added to these data.

From the data obtained, it is possible to calculate, in addition to the total volume of the pile, the diameter distri-

bution and the average length of the logs. Here it is possible to use a suitable mathematical model. There is no attempt to even try to calculate data for separate logs as such.

Patent Claims

1. A method for measuring the magnitudes of a pile (1) of logs, especially the volume of timber, characterized in that the outlines of the ends of the logs are recognized from both ends of the pile and that the location of the recognized outlines is measured and if necessary, the whole weight of the pile is measured, on the basis of which the desired magnitudes are calculated by means of a theoretical model.
2. A method in accordance with Patent Claim 1, characterized in that the total of calculated cylindrical volumes from each end to an intermediate point, in which the surface areas of recognized objects are used as the cross-sectional areas of the cylinders, is used as a theoretical model of the volume of timber.
3. A method in accordance with Patent Claims 1 or 2, characterized in that the object recognition of the ends of the logs is carried out in the following stages:
- the limit-value points of the digitalized picture are sought
 - curve nuclei of the width of a margin are fitted at the limit-values
 - the outline of the end of the log is approved for all those places or those in accordance with a certain criterion, in which the limit-value points concur with the curve nucleus with a sufficient density
 - each outline is formed by estimating the missing parts of the curve from a circle.
4. Equipment intended to realize the method in accordance with Patent Claim 1, one non-touching measuring unit of which is located in a standard position at one side of the pile fork (2), i.e. in the assumed longitudinal axis of the logs, characterized in that the measuring unit consists of a carrier (4) and its transfer devices (5), by means of which the carrier (4) can be moved over the entire measuring area defined by the pile fork (2), and on which carrier (4) there is an IR

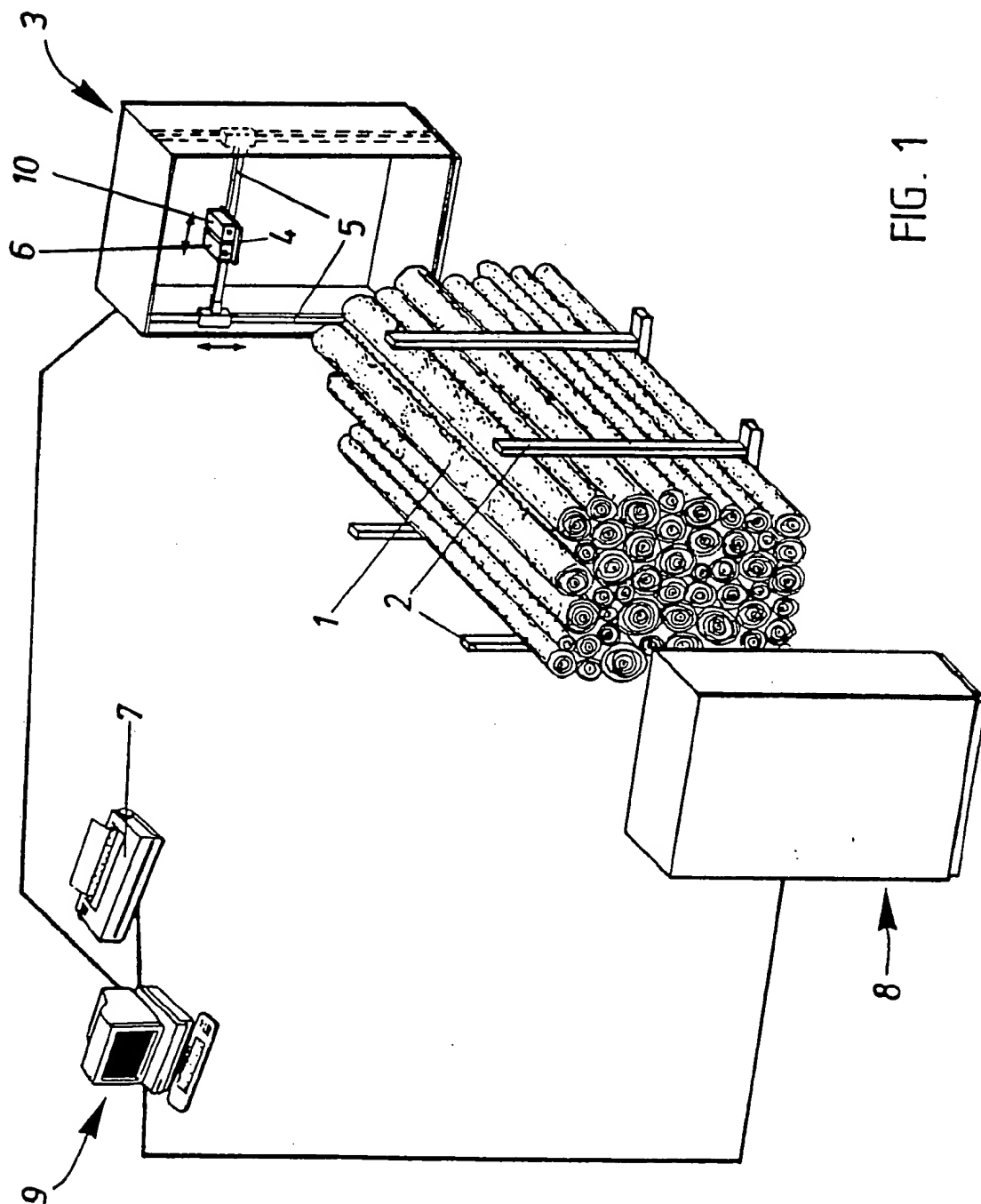
by the pile fork (2), and on which carrier (4) there is an IR pulse laser (10) or other distance meter operating on the time of the travel of light, and that the equipment includes:

- 5 - a camera or cameras (6) for depicting the entire measuring area
- a control device to control the carrier (4)
- devices to register the depiction and distance measurments
- 10 - calculating equipment (9) to handle the registered depictions and measurements.

5. Equipment in accordance with Patent Claim 4, characterized in that the equipment includes measuring unit (3,4) located at both sides of the pile fork (2).
15

6. Equipment in accordance with Patent Claim 4, characterized in that the equipment includes turning equipment for the pile fork (2), by means of which the pile can be turned through 180° and filming and measurments can be carried out
20 using only one measuring unit (3).

7. Equipment in accordance with Patent Claims 4,5 or 6, characterized in that a linear camera (6) is located on the carrier (4), so that its picture line passes over the entire
25 measuring area in either a single layer or in several layers.



INTERNATIONAL SEARCH REPORT

International Application No. PCT/FI 89/00028

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC4: G 01 B 11/00						
II. FIELDS SEARCHED <div style="text-align: center; font-size: small;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border: none;"> <tr> <td style="width: 25%; border: none; vertical-align: top;"> <div style="border: 1px solid black; padding: 2px;">Classification System</div> </td> <td style="border: none; vertical-align: top;"> <div style="border: 1px solid black; padding: 2px;">Classification Symbols</div> </td> </tr> <tr> <td style="border: none; vertical-align: top; padding-top: 10px;">IPC4</td> <td style="border: none; vertical-align: top; padding-top: 10px;">G 01 B; G 01 F</td> </tr> </table> <div style="text-align: center; font-size: x-small; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div>			<div style="border: 1px solid black; padding: 2px;">Classification System</div>	<div style="border: 1px solid black; padding: 2px;">Classification Symbols</div>	IPC4	G 01 B; G 01 F
<div style="border: 1px solid black; padding: 2px;">Classification System</div>	<div style="border: 1px solid black; padding: 2px;">Classification Symbols</div>					
IPC4	G 01 B; G 01 F					
SE, NO, DK, FI classes as above						
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹						
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³				
A	FI, B, 54971 (KAJAANI OY) 29 December 1978, see figure 2; claims 1-6 cited in the application --	1				
A	SE, B, 391580 (KAJAANI OY ELEKTRONIIKKA) 21 February 1977, see the whole document --	1				
A	US, A, 3852579 (SOHN ET AL) 3 December 1974, see abstract --	1				
A	FI, C, 37299 (LICENTIA PATENT-VERWALTUNGS-GMBH) 31 May 1969, see figure 1; claims 1-6 -- -----	1				
<div style="display: flex; justify-content: space-between; font-size: x-small;"> <div style="width: 48%;"> <p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>						
IV. CERTIFICATION						
Date of the Actual Completion of the International Search 1989-05-12		Date of Mailing of this International Search Report 1989-05-20				
International Searching Authority Swedish Patent Office		Signature of Authorized Officer Ingemar Josefsson				

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 89/00028**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FI-B- 54971	29/12/78	NONE	
SE-B- 391580	21/02/77	CA-A- 984959	02/03/76
US-A- 3852579	03/12/74	NONE	
FI-C- 37299	31/05/69	NONE	

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